



NAVAL FACILITIES ENGINEERING COMMAND
Washington, DC 20374-5065

NFESC
User Data Package
UDP-2006-ENV

**USER DATA PACKAGE FOR
POLYMER AND LIGNOSULFONATE TYPE
DUST SUPPRESSANTS**

by

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November 1999

19991215 069

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-018

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1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE November 1999	3. REPORT TYPE AND DATES COVERED Final; May 1999 through October 1999
4. TITLE AND SUBTITLE USER DATA PACKAGE FOR POLYMER AND LIGNOSULFONATE TYPE DUST SUPPRESSANTS		5. FUNDING NUMBERS
6. AUTHOR(S) Aviva Speceal, Gary Anguiano, and Robert Sandoval		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESSE(S) Naval Facilities Engineering Service Center 1100 23rd Avenue Port Hueneme, CA 93043-4370		8. PERFORMING ORGANIZATION REPORT NUMBER UDP-2006-ENV
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESSES Chief of Naval Operations Environmental Protection, Safety, and Occupational Health Division (N45) 2000 Navy Pentagon Washington, DC 20350-2000		10. SPONSORING/MONITORING AGENCY REPORT NUMBER
11. SUPPLEMENTARY NOTES Program was managed by the Naval Facilities Engineering Command, Washington, DC		
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.	12b. DISTRIBUTION CODE	

13. ABSTRACT (Maximum 200 words)

This User Data Package (UDP) was developed by Naval Facilities Engineering Service Center (NFESC), Port Hueneme, California as technical guidance for the use of polymer and lignosulfonate type dust suppressants. The UDP discusses the regulatory requirements and issues, the suitability of the suppressants for various field applications, and the physical and environmental considerations for dust suppressant selection. In addition, the UDP outlines site planning and preparation, product application, methods for evaluating dust generation, and maintenance of treated roads.

14. SUBJECT TERMS Dust suppressant, dust control, dust treatment, lignosulfonate, SSL, polyvinyl acrylic, PVA		15. NUMBER OF PAGES 55
		16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified
		20. LIMITATION OF ABSTRACT UL

EXECUTIVE SUMMARY

Wheeled and tracked vehicle operation on dry, unsurfaced landscapes creates tremendous amounts of fugitive dust as soil particles are dislodged and carried into the atmosphere through wind action. During wet weather, these dislodged soil particles are subject to water erosion, which has the potential to carry them into surface waters and thereby reduce water quality and create sedimentation problems for streams and wetlands.

Fugitive dust generated from helicopter, wheeled, and tracked vehicle training exercises has the potential to increase military vehicle maintenance, impair the visibility of military vehicle operators, and increase the likelihood of accidents and injury.

Historically, numerous products have been developed and used to control dust on unsurfaced landing zones, roads, and trails. Some products, such as used motor oils, industrial manufacturing wastes, and other petroleum based derivatives, have damaging environmental effects and their use is now prohibited. However, recent developments in dust-control technology have provided a number of environmentally safe materials similar in cost, efficacy, durability, and maintenance requirements, especially on unimproved roadways where rougher terrain may make traditional road maintenance more difficult and costly.

The dust control measure of most common resort is that of applying a material to the dust source that prevents the dust emissions. Dust control products currently on the market are categorized as petroleum oils/resins, lignosulfonates, asphaltic emulsions, or polymer emulsions. The information in this User Data Package (UDP) is intended to provide guidance to Public Work Centers, environmental, and safety managers in the use of polymer and lignosulfonate type dust suppressants. This UDP discusses the suitability of these dust suppressants, selection criteria, site preparation, product application, product evaluation, and maintenance of treated areas.

ACKNOWLEDGEMENT

This work was funded by the Pollution Abatement Ashore program, managed by Naval Facilities Engineering Command and sponsored by the Environmental Protection, Safety and Occupational Health Division (N45) of the Chief of Naval Operations. A majority of test and evaluation data was obtained from Natural Resources Environmental Affairs located at Marine Corps Air Ground Combat Center in Twentynine Palms, California.

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1.0 INTRODUCTION

Wheeled and tracked vehicle operation on dry, unsurfaced landscapes creates tremendous amounts of fugitive dust as soil particles are dislodged and carried into the atmosphere through wind action. During wet weather, these dislodged soil particles are subject to water erosion, which has the potential to carry them into surface waters and thereby reduce water quality and create sedimentation problems for streams and wetlands.

Fugitive dust generated from helicopter, wheeled, and tracked vehicle training exercises has the potential to create many different problems. Most notable of these are associated with safety, air quality, increased military vehicle maintenance requirements, and tactical considerations. Dust clouds generated from helicopter landing pads and tank trails impair the visibility of military vehicle operators and increase the likelihood of accidents and injury. Excessive dust from tank trails acts as a respiratory irritant to military operators and is considered a safety and air quality hazard when it drifts into nearby housing and administrative areas or onto adjacent highways and streets. Excessive wear and tear on military vehicles and aircraft results from the intrusion of dust into engine and turbine compartments, air-filtering systems, and other sensitive mechanical and electrical components. Finally, dust generated from helicopter and tank movement provides an unmistakable signature to enemy forces in a tactical scenario.

Historically, numerous products have been developed and used to control dust on unsurfaced landing zones, roads, and trails. Some products, such as used motor oils, industrial manufacturing wastes, and other petroleum based derivatives, have damaging environmental effects and their use is now prohibited. However, recent developments in dust-control technology have provided a number of environmentally safe materials similar in cost, efficacy, durability, and maintenance requirements, especially on unimproved roadways where rougher terrain may make traditional road maintenance more difficult and costly.

2.0 USER DATA PACKAGE FOR POLYMER AND LIGNOSULFONATE TYPE DUST SUPPRESSANTS

The dust control measure of most common resort is that of applying a material to the dust source that prevents the dust emissions. Products currently on the market available for use are too numerous to mention by name but most products fall into one of the following generic material categories:

- Petroleum Oils
- Petroleum Resins
- Lignin Sulfonates
- Asphaltic Emulsions
- Copolymer Emulsions

The information in this User Data Package (UDP) is intended to provide guidance to Public Work Centers, environmental, and safety managers in the use of polymer and lignosulfonate types of dust suppressants. This UDP discusses the suitability of these

dust suppressants, selection criteria, site preparation, product application, product evaluation, and maintenance of treated areas.

3.0 REGULATORY REQUIREMENTS AND PERMITTING ISSUES

Regulations governing construction/demolition activities, feedlot operations, landfill/disposal sites, open areas/staging areas handling and storage of bulk materials, paved roads, and unpaved roads require the permittee to prepare a written dust control plan to the air control agency as part of the permitting process. This plan must identify the measures and strategies to be followed by the permittee in preventing/controlling airborne emissions of particulate matter with diameters equal to or smaller than 10 microns. In addition, dust control measures must be environmentally safe. Any dust control products should not break down and become airborne emissions, nor should they present a threat to ground water, plant and/or animal life. Prior to procurement of a dust control product, consult with the regional air quality and water quality control agencies regarding the potential dust control products under consideration for use.

Air Quality regulations and Water Quality regulations are in potential conflict when it comes to selecting a dust control material. Air quality considerations require that dust emissions be prevented at the source and the use of dust control materials is often required. Water quality considerations require that no material be applied to the soil that will contaminate or damage the water supply.

Water and air quality control agencies sometimes have lists of products on the market that are available for use, but the products named on these lists are neither "approved" nor "not approved". At the present time, it is possible to select a product from a product list provided by one regulatory agency and that product could be totally unacceptable based on the environmental considerations of another regulatory agency. If a dust control product is environmentally unacceptable for a known reason, the agency can be expected to reject the product or limit its use and advise accordingly. However, the agency will not approve products that it has no reason to reject. Those products may be used to control dust. If a company or public agency submits a product to the water control agency and the water control agency does not reject the product, then the company or public agency remains responsible if it uses the product and later finds that the product is environmentally unsafe.

The use of acceptable product selection criteria, which provide meaningful information about the environmental acceptability of a dust control product, minimizes the possibility of an incorrect decision. The more thorough the product selection criteria, the more information available to help reach an environmentally correct decision. Section 8.0 discusses criteria for selecting dust control products. Appendix A includes points of contact information for various regulatory agencies.

4.0 DESCRIPTION OF POLYMER AND LIGNOSULFONATE SUPPRESSANTS

The primary objective of dust control materials is to prevent soil particles from becoming airborne. PVA and lignosulfonate type dust suppressants, as opposed to other types of dust suppressants, typically do not contain petroleum products and, therefore, are more compatible in sensitive environments and less likely to be rejected by regulatory agencies. PVAs and lignosulfonates are not soil stabilizers that increase the bearing strength of the trafficked area. Therefore, an important factor limiting the applicability of these dust palliatives in traffic areas is the extent of surface rutting that will occur under traffic, especially by tracked vehicles. The effectiveness of the treatment is destroyed rapidly by rutting and any remaining dust palliative is quickly stripped from the ground surface. Appendix B provides a partial list of vendors that supply PVA and lignosulfonate type dust suppressants.

4.1 Polymer Type Dust Suppressants

Polymer type dust suppressants are generally polyvinyl acrylic (PVA) proprietary emulsions modified with plasticizers, surfactants, and other compounds. The PVA dust control products are suitable for many types of soil and climatic conditions and have been used extensively throughout the United States by various mining industries for dust control on haul roads and stockpiles. The product is supplied in a concentrated form that resembles white latex paint yet, when cured, produces a clear hard surface-binding film that retards dust formation. PVA must be diluted with water before application according to each manufacturer's recommendation. Generally speaking, the dilution ratios range from 1:1 to 1:7 of product to water. Application rates range between 1/3 to 2/3 gal/yd². PVA type dust suppressants can be applied with a water truck equipped with spray bars or an asphalt distributor. A clear hard film is produced when cured by drying in approximately 4 hours depending upon ambient weather conditions.

4.2 Lignosulfonate Type Dust Suppressants

The lignin type dust suppressants are derived from an industrial paper making waste product that contains lignin and other carbohydrates in aqueous suspension. However, specific composition depends on the chemicals and processes used to extract the cellulose and the tree type. Lignin acts like a natural cement to bind the fibers of wood together in plants. Consequently, the lignin polymer and wood saccharides act as a glue to bind soil particles together when used in road treatment. The most common process used in extracting lignin from the pulping liquor is the sulfite process. The lignin derivative produced is called "lignosulfonate" and is water soluble. The term Spent Sulfite Liquor (SSL) is used interchangeably with lignosulfonate.

Initially, the aim of lignosulfonate treatment was simply dust-abatement, which was accomplished by spraying light applications of dilute raw lignosulfonate solutions onto dirt roads. The method gained importance when concentrated lignosulfonate was shown to promote the stabilization and consolidation of roadway mixtures. The lignosulfonates act essentially as clay dispersants, making the clay more plastic at lower moisture content which, after compression, leads to a denser, firmer road cap. For this reason, clay is very

important component of a good road soil, and a prerequisite for successful road binding with lignosulfonates. Once the road is properly compacted and consolidated, the void spaces between soil particles become minimal, water uptake is greatly reduced and loss of binder by rain leaching is minimized.

Lignosulfonates have been used extensively by the Department of Transportation and in the southwestern United States and the forestry industry in the western and southeastern United States for dust control on unsurfaced county and logging roads, respectively. The wide range of soil and climatic conditions encountered in these regions attest to its broad applicability. Generally speaking, a good soil mixture should contain particles less than 1 inch in diameter and should be composed of about 40 percent each of coarse and fine aggregate and of about 20 percent of clay and silt. An addition of at least 10 percent clay to a pure sand soil is recommended. If this is not feasible, using a lignosulfonate mixture of 50 percent total solids and 50 percent water is recommended.

The lignin-based dust suppressants are available in dry and concentrated liquid forms and must be mixed or diluted with water before application according to each manufacturer's recommendation. The dilution ratios typically range from 1:1 to 1:7 of product to water. Application rates range between 1/3 to 2/3 gal/yd². Most lignosulfonates type dust suppressants dry in approximately 4 hours depending upon ambient weather conditions. Lignin can be applied with a water truck equipped with spray bars or asphalt distributor capable of metered application at rates generally between 0.45 and 0.65 gallon per square yard.

Lignosulfonate solutions are noted to be corrosive to aluminum and its alloys due to the presence of caustic compounds used in the extraction process. Some products such as calcium carbonate can be added to raise the pH to minimize corrosivity. The carbonate is also noted to reduce the solubility of the compound and thus prolong the dust suppressing effect. The addition of dichromate to lignosulfonate in a chrome-lignin soil stabilization study revealed that the mixture formed a gel and acted as a waterproofing agent. The study also reported an increase in stability of the soil.

5.0 DUST SUPPRESSANT SUITABILITY FOR VARIOUS FIELD APPLICATIONS

Due to differences in traffic type and volume, soil types, and roadway/trail surface characteristics, product performance can and will vary. Neither lignosulfonate nor PVA type dust suppressants have successfully withstood traffic from track-equipped vehicles.

Lignosulfonates have successfully withstood the following field applications:

- Non-trafficked areas
- M927 truck traffic
- UH-1 helicopter traffic
- Wheeled-vehicle roadways and helipads located in desert, tropic and temperate climates.

PVAs have successfully withstood the following field applications:

- Non-trafficked areas located in desert climates.
- Wheeled-vehicle roadways and helipads located in desert, tropic and temperate climates.
- Dust areas adjacent to touchdown areas of C-130 aircraft, CH-47 helicopters, and all aircraft creating lesser wind velocities for a period of approximately 6 months.
- Areas subjected to foot traffic or rubber-tired traffic if the strength of the soil is adequate to support the loads.

6.0 CONSIDERATIONS FOR DUST SUPPRESSANT SELECTION

6.1 Soil Properties/Soil Survey

Soil surveys can help in evaluating the properties that effect the maintenance of roads open areas treated by dust suppressants. Among the important soil properties described in soil surveys are:

Natural soil drainage	Erodibility
Permeability	Acidity and alkalinity
Infiltration rate	Load bearing capacity
Flood hazard	Slope
Soil structure	Sand, silt, and clay content
Shrink-swell potential	Corrosivity

In addition, soil properties are key factors when selecting a suitable dust control product for unpaved roadways. Soil composition, grain size distribution, pH, and moisture content are general characteristics that are requested by the dust suppressant applicator to determine whether a given product will be effective, and to determine optimal application rates and methods.

6.2 Important Soil Characteristics

6.2.1 Grain Size Distribution And Plasticity Index

As previously mentioned, lignosulfonates act essentially as clay dispersants, making the clay more plastic at lower moisture content, which, after compaction, leads to a denser, firmer road surface. For this reason, soil fines are an important component of the road surface material and a prerequisite for successful road binding with lignosulfonates. One should compare the aggregate particle size distribution with the recommended aggregate mix to achieve a good surface course. Without sufficient fines the larger size aggregates cannot bind together into a tight matrix, and thus aggregate pullout is easier. The recommended aggregate particle size distribution percent passing No. 40 (425- μm) and No. 20 (75- μm) standard sieves are between 25-45 percent and 10-25 percent, respectively. For soils lacking in sufficient fines, such as sandy soils, one may either add

clay to the aggregate mix or use a PVA type dust suppressants. Appendix C includes a photo of a soil sieve for field use.

6.2.2 pH

The pH of the soil should be determined before selecting a particular dust suppressant since some dust suppression products break down in an alkaline soil. Appendix C includes a photo of a soil pH meter.

6.2.3 Moisture Content

Some manufacturers claim that their PVA and lignosulfonate type dust suppressants can be applied on dry soil. However, most manufacturers agree that product penetrability is increased if the soil has been prewetted. For dry soils, prewetting with water breaks the soil's surface tension and allows for a more uniform coverage of the dust control product.

6.2.4 Soil Strength

The California Bearing Ratio (CBR) test was recommended to the American Society for Testing and Materials (ASTM) as a standard test and is now designated as ASTM 1883. The CBR estimates the bearing value of sub-bases and sub-grades. Sub-bases are the road bed excavations while the sub-grades are the fill material laid on the sub-bases up to where the road surface is applied. The stronger the sub-base, the more likely the treated road will resist rutting and washboarding. The test consists of pushing a standard plunger into the soil at a constant rate and measuring, in suitable intervals, the force required in order to maintain that rate. The graphical load-penetration relationship can be drawn and the loads corresponding to standard penetrations are expressed as ratios (percent) of standard loads. The accepted percentage is known as the CBR value of the soil in the condition in which it was tested. The CBR value can be regarded as an indirect measure of the shear strength of the soil, but it cannot be directly related to shear strength parameters. Table 1 shows the CBR values (compacted density) for various soils and the type of compaction equipment required on the sub-base to achieve that CBR value.

Appendix C includes a photo of a field CBR jack. The jack consists of a corrosion-protected body that houses an enclosed worm and wheel gear. The carefully selected gear ratio provides a hand wheel speed that can be comfortably maintained particularly with soils of a high CBR value. A quick release device in the screw jack allows for rapid adjustment of the plunger prior to the test. Final adjustments are then carried out via the handwheel.

Table 1: CBR Values and Compaction Equipment for Various Soil Types

Major Soil Division	Soil Description	Drainage Characteristics	Compaction Equipment	Field CBR (Compacted Density)
Gravel and gravelly soils	Gravel or sandy gravel, well graded	Excellent	Crawler-type tractor, rubber-tired equipment, steel-wheeled roller	60-80
	Gravel or sandy gravel, poorly graded	Excellent	Crawler-type tractor, rubber-tired equipment, steel-wheeled roller	35-60
	Gravel or sandy gravel, uniformly graded	Excellent	Crawler-type tractor, rubber-tired equipment	25-50
	Silty gravel or silty sandy gravel	Fair to poor	Rubber-tired equipment, sheepfoot roller	40-80
	Clayey gravel or clayey sandy gravel	Poor to practically impervious	Rubber-tired equipment, sheepfoot roller	20-40
	Sand or gravelly sand, well graded	Excellent	Crawler-type tractor, rubber-tired equipment	20-40
Sand and sandy soils	Sand or gravelly sand, poorly graded	Excellent	Crawler-type tractor, rubber-tired equipment	15-25
	Sand or gravelly sand, uniformly graded	Excellent	Crawler-type tractor, rubber-tired equipment	10-20
	Silky sand or silty gravelly sand	Fair to poor	Rubber-tired equipment, sheepfoot roller	20-40
	Clayey sand or clayey gravelly sand	Poor to practically impervious	Rubber-tired equipment, sheepfoot roller	10-20
	Silts, sandy silts, gravelly silts, or diatomaceous soils	Fair to poor	Rubber-tired equipment, sheepfoot roller	5-15
	Lean clays, sandy clays, or gravelly clays	Practically impervious	Rubber-tired equipment, sheepfoot roller	5-15
Low compressibility soils	Organic silts or lean organic clays	Poor	Rubber-tired equipment, sheepfoot roller	4-8
	Micaceous clays or diatomaceous soils	Fair to poor	Rubber-tired equipment, sheepfoot roller	4-8
	Fat clays	Practically impervious	Rubber-tired equipment, sheepfoot roller	3-5
	Fat organic clays	Practically impervious	Rubber-tired equipment, sheepfoot roller	3-5
High compressibility soils				

6.2.5 Rate of Compaction

A penetrometer is used to assist identifying soil types using the most common soil behavior classifications by determining the rate of compaction for any soil at different depths. To use, constant pressure is applied on the handgrips to push the rod and cone into the soil. Resistance of the soil is determined by dividing the reading by the surface area of the selected cone. A drag counter records the highest measurement. A photo of a handheld penetrometer is included in Appendix C.

7.0 CLIMATOLOGY

The climate will have a varying influence on the performance of dust suppressant products depending on the product's chemical and physical properties. For example, products, such as lignosulphonates and uncured PVA, are soluble and may leach out under a heavy rain decreasing their effectiveness as well as posing a threat to contaminate groundwater. Due to potential impact on product performance, rain, temperatures, and humidity are discussed below.

7.1 Rain

Precipitation, even if infrequent, is important to product application for the following reasons:

- Most products will be diluted if rain were to fall during the curing process. This may cause a loss of product strength and durability.
- Rainwater can transport product down slope of the desired site before it has cured.
- Rainwater must be removed to prevent surface ponding, which accelerates road degradation.

DO NOT ATTEMPT TO APPLY DUST SUPPRESSANTS DURING OR BEFORE A RAIN. IF RAIN IS PREDICTED WITHIN 24 HOURS OF THE ANTICIPATED COMPLETION OF THE DUST SUPPRESSANT'S DRYING OR CURING TIME, THE PROJECT SHOULD BE POSTPONED.

7.2 Temperature

Temperature is important to product storage and application because many dust suppressant products are liquid in the stored state and are affected by extreme temperature. Specific issues that temperature may influence are:

- Time of year that product is applied.
- Transporting and storing dust suppression products.
- Product curing time.
- Speed of product application.

According to dust suppression/soil stabilizer distributors, some suppressants require a minimum temperature above 63 degrees Fahrenheit to cure. Cure time is also influenced

by temperature as it affects evaporation and chemical reaction. Desert temperatures can fluctuate dramatically reaching as high as 118 degrees F and as low as 18 degrees F.

7.3 Humidity

As opposed to other products that are hygroscopic and require a minimum of 30 percent humidity, lignosulfonate and PVA type dust suppressants may be used in low and high humidity conditions. One can expect curing times to increase or decrease in high or low humidities, respectively.

8.0 ENVIRONMENTAL PRODUCT SELECTION CRITERIA

The environmental safety of a dust control product may be ascertained by asking a series of questions that can provide the basis for determining the degree to which a product may be regarded as environmentally acceptable or unacceptable:

- Is the product toxic or harmful to humans or other forms of animal life?
- Is the product harmful to plant life?
- Does the product increase the alkalinity or acidity of the soil?
- Will the material leach into the groundwater or enter the water table?
- Is the material water insoluble or does the material dissolve in rain-water run-off and flow into streams, rivers, lakes or reservoirs?
- Does the material change the color or alter other physical characteristics of soil to which it is applied?
- Does the material emit harmful or odoriferous vapors?
- Is the material corrosive?
- Does the material deteriorate into dust and become a part of the dust problem after it has been applied?
- Is the material stable or is the material known to breakdown into harmful or toxic components after it has been applied?

By using questions like these as selection criteria, one can be relatively sure that proper environmental consideration is given to the selection of a dust control product. It is extremely unlikely that any dust control product will offer a favorable response to all of the questions. Depending on the situation, some of the questions are of primary importance and others are secondary. For example, it would be environmentally incorrect to select a water soluble dust control product to treat a roadway next to a trout stream. A dust control product that emits odoriferous vapors would not be the correct choice of product to control dust in a populated area. Once the responses to the selection criteria questions are determined, an environmentally correct decision is possible.

In any event, using acceptable selection criteria provides a method of rating or ranking the environmental acceptability of given dust control products. The use of acceptable selection criteria greatly reduces the possibility of inadvertently using a product that causes environmental damage.

9.0 DUST CONTROL SELECTION

The U.S. Army Environmental Center (USAEC) has developed a Dust Control Guidance and Technology Selection Key and the Dust Control Selection Key Field Guide. The key was designed to help military installations evaluate solutions for dust control problems. It recommends categories of chemical dust palliatives according to traffic volume, climatic factors, and soil types and textures. The categories include lignosulfonate and polymer type dust suppressants as well as other dust palliative types.

A copy of the Selection Key and Field Guide is included in Appendix D. Copies of the Selection Key and Field Guide may also be obtained by contacting the U.S. Army Environmental Hotline at (800) USA-3845, DSN 584-1699. The Web-based versions may be viewed at the following web site:

<http://aec.army.mil/prod/usaec/et/conserv/conserv.htm>

10.0 EQUIPMENT AND OPERATOR REQUIREMENTS

The following lists and briefly describes the equipment requirements for applying PVA and lignosulfonate type dust suppressants:

- A motor grader /scarifier is needed to scarify and blade the area to be treated.
- A water truck is required to prewet the surface.
- A pressure type distributor truck, equipped with a spray system in a manner that ensures a homogeneous mixture. The truck should also have a positive displacement pump.
- A pneumatic tire or smooth drum compactor is required to compact the soil during the application process.

Experienced operators are required for the motor grader, compaction equipment, water truck, and asphalt distributor. A civil engineering technician or an engineer familiar with dust control material application should be present when the material is being placed.

Photos of the required application equipment are included in Appendix E.

11.0 SITE PLANNING AND PREPARATION

The following is a general procedure for planning the application of dust control products to an area:

- 1) Determine the area to be treated (square yards).
- 2) Evaluate the surface soils and classify according to Unified Soil Classification System. Consult TM 5-830-3/AFM 88-17, Chap.3 (Headquarters, Departments of the Army and Air Force 1987) and with product manufacture representatives to determine suitability of treatment method and application rates.
- 3) Select a suitable dust suppressant that is compatible with the soil and the environment. Section 15.0 discusses basic methodologies to test and evaluate the effectiveness of dust suppressants if a field study is required prior to product selection.
- 4) Order enough material to treat the area.
- 5) Plan the project so equipment and personnel are available to accomplish the preparation and application procedures in an orderly step-by-step process.
- 6) Select a storage area for the materials near the project site.
- 7) Locate a convenient water point. The water point should be located and a large capacity (4,000-5,000 gallons) water distributor is recommended. If a stream or pond is used for the water point, a pump will be required to fill the distributor. If prewetting is performed, any water that has ponded should be broomed or swept away before product is applied.

12.0 PRODUCT APPLICATION

12.1 Application of Polymer Type Dust Suppressants

The following lists a *general* construction procedures for applying polymer type dust control products to an area. Actual procedure may vary according to specific product manufacturer's recommendations. For example, compaction may be required before and/or after the application step or the prewet step. Some products do not require the prewet step or/and others may require two to three coats in varying concentrations. Testing may be necessary to determine the procedure that works best for a particular soil type.

- 1) Scarify the surface to the lowest depth of any low spot in the roadway, typically a depth of approximately 6 inches. It may be necessary to water down the road surface if it is very dry.
- 2) Blade away all ruts, potholes, washboard, and loose excess surface material.
- 3) Grade the road to provide a smooth even surface and a center crown for proper drainage. The center crown should be a minimum of at least one inch of height per ten feet of width.
- 4) Compact the bladed surface as necessary with a pneumatic rubber-tired roller to ensure a hard surface is achieved so that rutting is not caused by traffic. Dust control materials do not impart any additional strength to the soil. Therefore, time spent

compacting loose material prior to treatment enhances the effectiveness of the dust control system.

- 5) Prewet the selected area as necessary to reduce surface tension and increase the penetration and uniformity of the dust control product. Typically, recommended application rates for the prewetting operation are between 0.03 to 0.30 gallons per square yard. Application rate is dependent upon temperature, soil type, and evaporation rate.
- 6) Prepare diluted PVA mixture in distributor truck. Follow dilution ratios as specified by the product manufacturer. Prior to spraying, make sure that there is no water or other material inside the spray bar lines or the first few feet of the spray application may not contain any polymer. The actual soil moisture conditions might require a slight adjustment in the dilution and spread ratios.
- 7) Spray the dust control product with a device capable of metered application at the manufacturer's recommended application rate. A 6 to 12 inch overlap of treated strips is required to ensure a uniform application is maintained on the treated area. If excessive run-off occurs the spread rate may be reduced and the spray application may be made in two spray passes to achieve the required total. Also, depending upon the particular product used, several product passes may be required. Sometimes the product to water ratios will vary with each pass or just the final pass.
- 8) Allow treated area to cure until vehicle passage can be achieved without the treated material sticking to the wheels. Drying time cannot be predicted with accuracy. It will vary with the weather. It is not a critical time period. The objective is to avoid compacting the polymer-treated soil too early or it might rut or stick to the roller. Pre-wetting the roller will help prevent sticking.
- 9) Compact treated area as necessary after curing is complete. Finer grained soils generally require some compaction, whereas coarse gravel does not. Compaction can increase the effectiveness of the polymer application by as much as 50 percent.

12.2 Application of Lignosulfonate Type Dust Suppressants

The following subsections describe two methods of general construction procedures for applying lignosulfonate type dust control products onto an area.

12.2.1 Method A

- 1) Scarify the surface to the lowest depth of any low spot in the roadway, typically a depth of approximately 6 inches. It may be necessary to water down the road surface if it is very dry.
- 2) Blade away all ruts, potholes, washboard, and loose excess surface material.
- 3) Grade the road to provide a smooth even surface and a center crown for proper drainage. The center crown should be a minimum of at least one inch of height per ten feet of width.
- 4) Compact the bladed surface as necessary with a pneumatic rubber-tired roller to ensure a hard surface is achieved so rutting is not caused by traffic. Dust control materials do not impart any additional strength to the soil. Therefore, time spent

compacting loose material prior to treatment enhances the effectiveness of the dust control system.

- 5) Prewet the selected area as necessary to reduce surface tension and increase the penetration and uniformity of the dust control product. Recommended application rate for the prewetting operation is between 0.03 to 0.30 gallons per square yard. Application rate is dependent upon temperature, soil type, and evaporation rate.
- 6) Dilute dust control product in distributor truck. Follow dilution ratios as specified by the product manufacturer. Prior to spraying, make sure that there is no water or other material inside the spray bar lines or the first few feet of the spray application may not contain any polymer. The actual soil moisture conditions might require a slight adjustment in the dilution and spread ratios.
- 7) Spray the dust control product with a device capable of metered application at the manufacturer's recommended application rate. A 6 to 12 inch overlap of treated strips is required to ensure a uniform application is maintained on the treated area.
- 8) Using a Drum Roller, compact before the product dries.

12.2.2 Method B

- 1) Scarify the surface to the lowest depth of any low spot in the roadway, typically a depth of approximately 6 inches. It may be necessary to water down the road surface if it is very dry.
- 2) Blade away all ruts, potholes, washboard, and loose excess surface material.
- 3) Grade the road to provide a smooth even surface and a center crown for proper drainage. The center crown should be a minimum of at least one inch of height per ten feet of width.
- 4) Dilute dust control product in distributor truck. Follow dilution ratios as specified by the product manufacturer. Prior to spraying, make sure that there is no water or other material inside the spray bar lines or the first few feet of the spray application may not contain any polymer. The actual soil moisture conditions might require a slight adjustment in the dilution and spread ratios.
- 5) Spray the dust control product onto the remaining three inches of scarified soil using a spray device capable of metered application at the manufacturer's recommended application rate. Lay out the soil and prepare for compaction.
- 6) Compact the bed for a smooth surface using a rubber-tired compactor. Do not use a sheepfoot roller. Dust control materials do not impart any additional strength to the soil. Therefore, time spent compacting loose material prior to treatment enhances the effectiveness of the dust control system.
- 7) Pull the windrowed material to the center of the road-bed and spread evenly.
- 8) Spray on diluted lignosulfonate according to the manufacturer's recommended rate.
- 9) Blade and mix the top three inches of the road bed.
- 10) Compact the road immediately.
- 11) Level and crown the road to provide slope to prevent ponding.

13.0 TEST BED SELECTION CRITERIA

Sometimes testing several products in the field is necessary to determine the product best suited for a particular soil and/or field operation. Selecting an appropriate test site is critical since many variables can skew the test results. If at all possible, a straight level unpaved stretch of road with uniform soil is desired. Section the roadway into 0.3-mile-long sections in preparation for application of dust-control treatments. Prior to dust-control agent application, all roadway and tank trail segments should be graded to remove excess surface material, potholes, and washboarding. Install magnetic traffic counters to record traffic volume. This data can be used to relate traffic volume to dust-control agent effectiveness and durability. Following grading and traffic counter installation, each 0.3-mile-long roadway and tank trail section should be treated with each of test dust suppressants following the manufacturer's application recommendations.

The wind conditions can also have an influence on the performance evaluation of dust suppressant and soil stabilizers. Wind speed and direction are key elements of importance since any test area evaluated will have some exposure to fugitive dust transported by wind. Field tests will require an evaluation of adjacent land use based on their potential to contaminate sites with fugitive dust. Wind speed is also important from the standpoint that it affects soil lift and dust generation. These variances occur when wind blows migrate dust into or out of the proposed test bed area, and should be considered when evaluating different test products. Generally speaking, the optimum test bed or road section orientation should be perpendicular to the prevailing winds.

14.0 TEST MONITORING

Following application to a roadway, select a control speed (i.e. 30 mph) and post the desired speed sign along the test roadway. Set up a traffic counter to record traffic volume and allow normal traffic to resume. Immediately begin dust control/traffic test monitoring of each treatment in each road way section for three to six months. Record traffic volume via the traffic counter and use data to estimate monthly traffic volume as it relates to product durability over time. Road test sections should be inspected and monitored after each rain event.

The performance of each dust control material should be documented by recording visual observations in a field notebook as traffic tests are being conducted and after the completion of tests. Visually inspect traffic as it passes along the road test sections, recording when dust generation begins. Note when ruts, potholes, and washboarding begin to develop. It is also suggested that the pilots of aircraft that operate on treated runways be interviewed to determine the extent of dust control on assault runways. Normally a treated area can be expected to be effective for approximately six months to one year, but the effectiveness of any dust control product is largely dependent upon weather conditions and the volume and type of vehicles that traffic the treated area.

15.0 METHODS FOR EVALUATING DUST GENERATION

Commercial and military activities have employed numerous products in an attempt to control dust generated from vehicles traveling over unpaved roadways. Frequently, dust suppressant products are selected based on one or more of the following criteria: manufacturers' literature review, product's past performance, bench scale testing, and field evaluation. Numerous tests and evaluations have been performed to quantify dust generated from vehicles traveling over unpaved road. Testing the best product candidates can help determine the best product for a given set of soil and climate conditions. Numerous methods used to evaluate dust generation includes one or more of the following methods: sedimentation, filtration, or photometric. The following is a brief description of the limitations and advantages of these three methods. These methods used to evaluate the effectiveness of dust suppressants vary from simple to complex and inexpensive to expensive. It is possible to employ these methods of evaluation periodically throughout the duration of a test. Depending upon the product and test situation, it may only be necessary to evaluate product performance once a week for three months or once a month for a year. For areas requiring highly advanced methodologies to evaluate dust generation, one may refer to *Test Evaluation of Dust Suppression Product Conducted for Marine Corps Air Ground Combat Center*, a site-specific report which is included in the list of references on page 20 of this UDP.

15.1 Sedimentation

Sedimentation is a fairly inexpensive method to determine dust generation rates. The method, which depends on gravitational forces to settle out lifted dust, is a mass measurement technique using open top collectors such as cans or glass jars to trap dust particles. These containers are positioned at various distances from a treated roadway. After an exposure for a set period of time, typically 30 days, the particulate in each container is weighed and compared to other treated test areas. Variables that skew direct comparison exist in open field studies (and uncontrolled traffic), where different products are laid in parallel or adjacent to one another. In general, these variables have been the cause of dispute. The concern is not so much with the capture collection method, but with the uncontrolled source of the dust captured. Influencing factors are cross contamination from adjacent test plots, product carry-over from adjacent areas, variations in soil, and unequal exposure to rain water run-off. Other variables such as fugitive dust, traffic flow, braking, variable vehicle speed, weight and shape of vehicles can also skew direct comparison.

The following describes a simple sedimentation test procedure:

Following application to roadway, select a control speed (i.e. 30 mph) and post along test roadway. Place a tared, oil-coated dust collection pan at each corner of the helipad to be evaluated. Place on each side of the treated roadways, tared, oil-coated dust collection pans between 15 and 20 feet away from the center of the road or trailing positions that avoid possible contamination from adjacent treatments. Allow normal traffic to resume and begin recording counter data. After the set test period has passed, retrieve dust collection pans and reweigh, and determine the amount of dust collected.

Relate the amount of dust collected to the traffic volume to estimate product durability over time.

15.2 Filtration

Quick results can be obtained by using the filtration method to determine dust generation. Filtration basically consists of high volume air samplers that collect dust by using a vacuum pump and filter medium. The air samplers should be capable of accurately measuring airborne particulate matter utilizing 8 in. by 10. in filter paper that traps particles as small as 0.01 micron size. Mount the samplers on a tripod positioning the filter paper 42 inches above the ground. Filter systems can also be mounted on moving vehicles.

The main concern with past tests performed using filtration technology is the variability of traffic and wind conditions on sections of treated roadway. Dust capture will vary because ambient wind conditions are not uniform, causing variability at the dust collection capture point. Costs are high, since several vacuum pump systems must be placed at various locations around the test strips so that wind changes can be modeled into dust capture mass determination. To avoid modeling, some activities have mounted a vacuum system close to the tire of a test vehicle. This method has provided some quantitative results.

The following describes a filtration test procedure:

Following application to roadway, select a control speed (i.e. 30 mph) and post along test roadway. Place a filtration system at each corner of a helipad to be evaluated. Place filtration systems at the midway point of each test section of roadway, one on each side of the road. Begin recording counter data and running the air samplers. Samplers are typically run for periods of 2 to 4 days. Allow normal traffic to resume. After the predetermined test period has passed, retrieve the tared filters, and determine the amount of dust collected. Relate the amount of dust collected to the traffic volume to estimate product durability over time.

15.3 Photometric Method

The photometric method is based on measuring light transmission through the dust cloud created by a passing vehicle on an unpaved road. Opacity measurements are taken right after passage of a control vehicle across a select point. Generally speaking, the method is subject to the same inaccuracy as the previous two and is subject to additional uncertainties caused by the equipment's response to wind speed, wind direction, sunlight intensity and cloud cover.

Videographic images can be used during every traffic test to evaluate and quantify the degree of dust control afforded by the different agents. The following describes a videographic test procedure:

Following application to roadway, select a control speed (i.e. 30 mph) and post along test roadway. On the shoulder of the treated roadway section, install a six-foot long board vertically along the edge of each roadway test item at the center of the item. Paint the board white and mark with black symbols and numbers so the height and density of the dust clouds generated by the traffic vehicles can be determined. Begin recording counter data and allow normal traffic to resume. Use a video camera and 35 mm camera to obtain video tape and photographs of dust obscuration levels immediately preceding and at five seconds after controlled vehicle traffic passes the white board. Digitize the images and analyze for level of obscurity using computer image processing techniques to determine changes in the mean value level of images due to dust. Relate the dust generation levels.

16.0 HEALTH AND SAFETY

16.1 General Guidelines

The following guidelines should be followed when handling any dust suppressant:

- All products should be kept out of watercourses, storm drains, drainage ditches, municipal and open bodies of water. Product should be applied with as little runoff as possible.
- Insure adequate ventilation when applying product.
- Temperatures of stored products should be kept above 40 degrees Fahrenheit and below 120 degrees Fahrenheit.
- Personal Protective Equipment should be used when applying product.
- The polymer products yield trace amounts of individual, residual monomers under thermal decomposition.
- In case of skin contact, wash the affected area thoroughly with water.
- Accidental spills should be hosed down and diluted with water.
- Disposal should be in accordance with federal, state, and local regulations.

Carefully read the Material Safety Data Sheets (MSDS) for the product to determine whether the dust suppressant product may pose a risk to human health and the environment. Although many products are considered biodegradable, it is advised to check with the manufacturer and MSDS. Comparing analytical tests on samples of untreated soil and treated soils can determine the background concentrations of metals in the soil and the concentration of any organic solvents in the dust suppressant product. Some of these tests may include Total Threshold Limit Concentration (TTLC), Soluble Threshold Limit Concentration (STLC), Total Organic Carbon (TOC).

16.2 Guidelines For PVA Solutions

The following are special guidelines for handling PVA solutions:

- When PVA is used, it must be transported, stored, and permitted to cure at a minimum temperature of 40 degrees Fahrenheit. If allowed to freeze, this material crystallizes, which is an irreversible process.
- In areas where freezing is known to occur, the product should be kept in drums stored inside a building or inside an insulated storage tank.

16.3 Guidelines For Lignosulfonate Solutions

The following are special guidelines for handling lignosulfonate solutions:

- Lignosulfonate solutions should be stored in vented tanks. Mild-steel is compatible with the lignosulfonate solutions. It is recommended that storage tanks have some means of agitation. Lignosulfonate solutions should be maintained at temperatures sufficient to provide suitable viscosities. Internal tank coils or tube bundles using either hot-water heat or low-pressure steam heat are recommended.
- Centrifugal pumps should be used to transfer lignosulfonate solutions, whereas positive displacement pumps with low rpm are recommended to meter the product. All pumps should have mechanical seals or lubricated (non-grease) packing. Transfer lines should be heat traced and insulated.
- Lignosulfonate solutions are biodegradable and contamination by naturally occurring airborne organisms can occur and cause pressure to develop if the fermenting material is placed in a sealed container.
- As with all organic material, caution is advised when storing or handling this product near strong oxidizing agents.
- Prolonged and excessive heating of lignosulfonate solutions can result in decomposition and the release of toxic sulfur dioxide fumes.
- In addition to the use of appropriate protective clothing (e.g. goggles, rubber gloves), a suitable respirator is recommended for the hot vapors of solution.

17.0 MAINTENANCE OF TREATED ROADS

Normally a treated area can be expected to be effective for approximately six months to one year, but the effectiveness of any dust control product is largely dependent upon weather conditions and the volume and type of vehicles that traffic the treated area. Generally speaking, treated roads should be inspected monthly and after each rain event. Traffic wear over a period of time may result in formation of potholes and raveling of the treated surfaces. This is especially true when water accumulation occurs on the surface by an improperly shaped crown or when the aggregate is insufficiently mixed with binding soil. Maintaining treated roads can vary from product to product. The following subsections address methods to repair damaged roads.

17.1 Maintenance of Roads Treated with PVA

Surface aggregate material can reduce the effectiveness and durability of some polymers. Vehicle movement across aggregate covered surfaces causes surface abrasion and shifting, which can quickly destroy the sealing/binding characteristics associated with a particular polymer. Polymers are surface sealers and binders requiring a relatively smooth, stable road surface to maximize performance. In addition, PVA is biodegradable and will dissolve from a treated soil area with continued exposure. For low traffic areas, a second application at one-half the rate of the first application should be planned following 10 to 14 months of service. For high traffic areas, a similar type application should be planned following six months of service.

For roads treated with PVA type dust suppressants, the preferred method for minor repair is patching rather than total regrading or blading. Patching mixtures should have a composition similar to that of the road surface. To repair potholes fill the holes with a 1 to 1 product to water mix. Fill the holes with dirt and allow the dirt to absorb the polymer until saturated. After saturation is complete, tamper the dirt down. Follow with a topcoat of polymer and allow the road to dry.

17.2 Maintenance of Roads Treated with Lignosulfonates

For roads treated with lignosulfonates, the preferred method for minor repair is patching rather than total regrading or blading. Patching mixtures should have a composition similar to that of the road surface. Use a lignosulfonate solution to moisten the bottom of the potholes. Fill the pothole with a patching soil-binder mixture and compact. The patching mixture should contain at least 1 percent lignosulfonate solids based on soil weight.

If raveling, pothole formation or dusting becomes excessive, the surface must be reworked. This is best done after a rain, or after pretreatment with water or a lignosulfonate solution to soften the surface. The road surface is then best cut to the bottom of the potholes, and the loose material treated as suggested under Section 12. Grading of the dry, treated road loosens the bonded road surface and may create some dusting. Hence, grading should only be done when general shaping, or major repair is needed.

References

Addo, J.Q. and Sanders, T.G. *Effectiveness and Environmental Impact of Road Dust Suprressants*. Department of Civil Engineering, Colorado State University, Fort Collins CO, March 1995.

Anguiano, G., Sandoval R., and Webb T. *Evaluation of Dust Suppression Products Conducted for the Marine Corps Air Ground Combat Center, Twentynine Palms, CA*. Site Specific Report SSR-2343-ENV, Naval Facilities Engineering Service Center, Port Hueneme, CA, Nov. 1997.

Gebhart, D.L. and Hale, T.A. *Dust Control Material Performance on Unsurfaced Roadways and Tank Trails*. U. S. Army Construction Engineering Research Laboratories, Champaign, IL, Sept. 1996.

Grau, R.H. *Evaluation of Methods for Controlling Dust*. Technical Report GL-93-25, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, Sept. 1993.

Grau, R.H. *Dust Proofing Unsurfaced Areas*. Miscellaneous Paper GL-92-9, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, March 1992.

APPENDIX A

REGULATORY AGENCIES

POINTS OF CONTACT

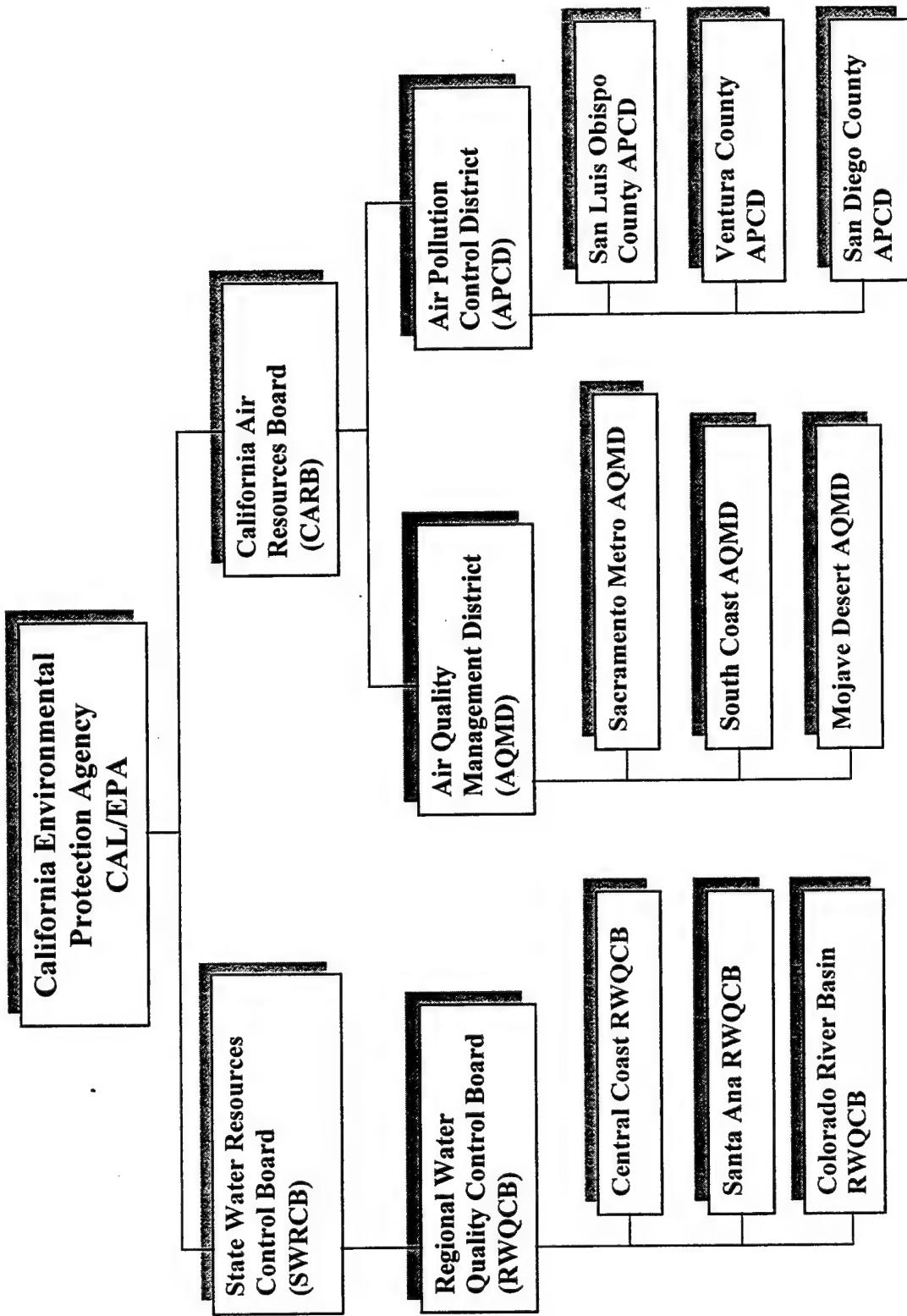


Figure 1. State of California Regulators Applicable to Dust Suppressant Polymer Products.

Cal/EPA Flowchart Summary

The U.S. Environmental Protection Agency (EPA) established regional offices within selected states that are responsible for the execution of the Agency's programs, for determining regional needs, and for the implementation of Federal environmental laws. The California Environmental Protection Agency (Cal/EPA) Region 9 is responsible for coordinating and prioritizing California's efforts to protect the environment. The mission of Cal/EPA is to improve the environmental quality in order to protect public health, the welfare of citizens, and California's natural resources. A manufacturer or vendor of a dust suppressant product would require product approval from the local water and air regulators within the district or region in the State. Figure 1 shows how water and air regulating agencies are delineated.

The State Water Quality Control Board (SWQCB) enforces water quality regulations. The mission of the SWQCB is to ensure the highest reasonable quality of waters in the State, while allocating those waters to achieve an optimum balance of beneficial uses. The joint authority of water allocation and water quality protection enables the SWQCB to provide comprehensive protection of California's waters.

There are nine Regional Water Quality Control Boards (RWQCBs). The mission of these agencies is to develop and enforce water quality objectives and to implement plans that best protect the uses of the State's waters, while recognizing local differences in climate, topography, geology, and hydrology. Some examples of these districts are the Colorado River Basin Regional Water Quality Control Board and the Santa Ana Regional Water Quality Control Board. Approval from the RWQCB is required prior to applying a dust suppressant product.

The California Air Resources Board (CARB) is a part of Cal/EPA. The mission of the California Air Resources Board is to promote and protect public health, welfare, and ecological resources through the effective and efficient reduction of air pollutants while recognizing and considering the effects on the economy of the State. The major goals of the board are to: (a) provide a safe, clean air to all Californians, (b) protect the public from exposure to toxic air contaminants, (c) provide innovative approaches for complying with air pollution rules and regulations, and (d) base decisions on scientific and economic information.

Under CARB, the state is divided into Air Pollution Control Districts (APCD) and Air Quality Management Districts (AQMD). These agencies are county or regional governing authorities that have primary responsibility for controlling air pollution from stationary sources. California is divided geographically into 14 regional air basins for the purpose of managing the air resources of the State. An air basin generally has similar meteorological and geographic conditions throughout given areas. Areas within each air basin are considered to share the same air masses, and are, therefore, expected to have similar ambient air quality.

Air Pollution Control Districts include San Luis Obispo APCD, Ventura County APCD, and San Diego County APCD. Air Quality Management Districts include Sacramento Metro AQMD, South Coast AQMD, Mojave Desert AQMD, and Air Quality Management District. Approval from either the APCD or the AQMD is required prior to application of any dust suppressant product.

Regional EPA Locations and Contacts

Region 1 (CT, MA, ME, NH, RI, VT)

Environmental Protection Agency
1 Congress St. Suite 1100
Boston, MA 02114-2023
<http://www.epa.gov/region01/>
Phone: (617) 918-1111
Fax: (617) 565-3660
Toll free within Region 1: (888) 372-7341

Region 2 (NJ, NY, PR, VI)

Environmental Protection Agency
290 Broadway
New York, NY 10007-1866
<http://www.epa.gov/region02/>
Phone: (212) 637-3000
Fax: (212) 637-3526

Region 3 (DC, DE, MD, PA, VA, WV)

Environmental Protection Agency
1650 Arch Street
Philadelphia, PA 19103-2029
<http://www.epa.gov/region03/>
Phone: (215) 814-5000
Fax: (215) 814-5103
Toll free: (800) 438-2474
Email: r3public@epa.gov

Region 4 (AL, FL, GA, KY, MS, NC, SC, TN)

Environmental Protection Agency
Atlanta Federal Center
61 Forsyth Street, SW
Atlanta, GA 30303-3104
<http://www.epa.gov/region04/>
Phone: (404) 562-9900
Fax: (404) 562-8174
Toll free: (800) 241-1754

Region 5 (IL, IN, MI, MN, OH, WI)

Environmental Protection Agency
77 West Jackson Boulevard
Chicago, IL 60604-3507
<http://www.epa.gov/region5/>
Phone: (312) 353-2000
Fax: (312) 353-4135
Toll free within Region 5: (800) 621-8431

Region 6 (AR, LA, NM, OK, TX)

Environmental Protection Agency
Fountain Place 12th Floor, Suite 1200
1445 Ross Avenue
Dallas, TX 75202-2733
<http://www.epa.gov/region06/>
Phone: (214) 665-2200
Fax: (214) 665-7113
Toll free within Region 6: (800) 887-6063

Region 7 (IA, KS, MO, NE)

Environmental Protection Agency
901 North 5th Street
Kansas City, KS 66101
<http://www.epa.gov/region07/>
Phone: (913) 551-7003
Toll free: (800) 223-0425

Region 8 (CO, MT, ND, SD, UT, WY)

Environmental Protection Agency
999 18th Street Suite 500
Denver, CO 80202-2466
<http://www.epa.gov/region08/>
Phone: (303) 312-6312
Fax: (303) 312-6339
Toll free: (800) 227-8917
Email: r8eisc@epa.gov

Region 9 (AZ, CA, HI, NV)

Environmental Protection Agency
75 Hawthorne Street
San Francisco, CA 94105
<http://www.epa.gov/region09/>
Phone: (415) 744-1305
Fax: (415) 744-2499
Email: r9.info@epa.gov

Region 10 (AK, ID, OR, WA)

Environmental Protection Agency
1200 Sixth Avenue
Seattle, WA 98101
<http://www.epa.gov/region10/>
Phone: (206) 553-1200
Fax: (206) 553-0149
Toll free: (800) 424-4372

Additional EPA Locations and Contacts

<p>U.S. EPA 26 Martin Luther King Drive Cincinnati, Ohio 45268</p> <p>U.S. EPA National Air and Radiation Environmental Laboratory (NAREL) 540 South Morris Avenue Montgomery, AL 36115-2601 http://www.epa.gov/narel/ Phone: (334) 270-3400 Fax: (334) 270-3454</p>	<p>U.S. EPA Research Triangle Park, North Carolina 27711 http://www.epa.gov/rtp/</p> <p>U.S. EPA National Health and Environmental Effects Research Laboratory (NHEERL) Gulf Ecology Division Sabine Island Drive Gulf Breeze, FL 32561 http://www.epa.gov/ged/ Phone: (850) 934-9200 Fax: (850) 934-9201</p>
<p>U.S. EPA National Enforcement Investigations Center Laboratory Box 25277, Bldg. 53 Denver Federal Center Denver, CO 80225 http://www.epa.gov/oeca/oceft/neic/ Phone: (303) 236-5132</p>	<p>U.S. EPA National Health and Environmental Effects Research Laboratory (NHEERL) Mid-Continent Ecology Division 6201 Congden Boulevard Duluth, MN 55804 http://www.epa.gov/med/ Phone: (218) 720-5703</p>
<p>U.S. EPA National Exposure Research Laboratory (NERL) Mail Code: MD-75 Research Triangle Park, NC 27711 http://www.epa.gov/nerl/ Phone: (919) 541-2106 Fax: (919) 541-0445</p>	<p>U.S. EPA National Health and Environmental Effects Research Laboratory (NHEERL) Western Ecology Division 200 SW 35th Street Corvallis, OR 97333 http://www.epa.gov/wed/ Voice: 541-754-4600 Fax: 541-754-4799</p>
<p>U.S. EPA National Exposure Research Laboratory (NERL) Ecosystems Research Division 960 College Station Road Athens, GA 30605-2700 http://www.epa.gov/AthensR/ Phone: (706) 355-8005</p>	<p>National Risk Management Research Laboratory 26 Martin Luther King Drive Cincinnati, Ohio 45268 http://www.epa.gov/ORD/NRMRL/ Fax: 513-569-7680</p>
<p>U.S. EPA National Exposure Research Laboratory (NERL) Environmental Sciences Division P.O. Box 93478 Las Vegas, Nevada 89193-3478 http://www.epa.gov/crdlvweb/ Phone: (702) 798-2100 Fax: (702) 798-2637</p>	<p>National Risk Management Research Laboratory (NRMRL) Subsurface Protection and Remediation Division P.O. Box 1198 Ada, OK 74820 http://www.epa.gov/ada/ Phone: (580) 436-8500</p>

Additional EPA Locations and Contacts (Continued)

U.S. EPA National Health and Environmental Effects Research Laboratory (NHEERL)
Mail Code: MD-51
Research Triangle Park, NC 27711
<http://www.epa.gov/nheerl/>
Phone: (919) 541-2281
Fax: (919) 541-4324

U.S. EPA National Health and Environmental Effects Research Laboratory (NHEERL)
Atlantic Ecology Division
27 Tarzwell Drive
Narragansett, RI 02882
<http://www.epa.gov/aed/>
Phone: (401) 782-3001
Fax: (401) 782-3030

National Risk Management Research Laboratory (NRMRL)
Water Supply and Resources Division
Urban Watershed Management Branch
2890 Woodbridge Avenue (MS-104)
Edison, NJ 08837
<http://www.epa.gov/ednnrmrl/>

U.S. EPA National Vehicle and Fuel Emissions Laboratory (NVFEL)
2565 Plymouth Road
Ann Arbor, MI 48105
Phone: (734) 668-4333

U.S. EPA Radiation and Indoor Environments National Laboratory
P.O. Box 98517
Las Vegas, NV 89193-8517
<http://www.epa.gov/radiation/rienl/>
Phone: (702) 798-2476

APPENDIX B

LIST OF DUST SUPPRESSANT SUPPLIERS

Vendors For Polymer Type Dust Suppressants

DCA-1295
Union Carbide Corporation
40 Veronica Avenue
Somerset, NJ 08873
(201) 823-3793

Polybilt 4178
DeWitt Company
Highway 61 South
RR 3 Box 338
Sikeston, MO 63801

Soil Master WR, Soil Master WRI
Earth Systems International, Inc.
28259 Dorothy Drive
Agoura Hills, CA 91301

Weather Tect, Weather Tect MSS
Weather Tect, Inc.
9209 Seminole Blvd. #93
Seminole, FL 34642

Magna-Coat
Gustafson, Inc.
1400 Preston Road, Suite 400
Plano, TX 75075

Soil Master WR
Earth Systems International, Inc.

Bartlett Services, Inc.
60 Industrial Park Road
Plymouth, MA 02360

Benetech, Inc.
1750 Eastwood Drive
Aurora, IL 60506

Dust Pro
725 S. 12th Place, AZ 85034
(602) 251-3659

Earth Systems International
28259 Dorothy Drive
Agoura Hills, CA 91301

Energy Systems Associates
P.O. Box 976
McLean, VA 22101

Executive Resource Associates
Suite 813, One Crystal Park
2011 Crystal Drive
Arlington, VA 22202

Midwest Industrial Supply, Inc.
P.O. Box 8431
Canton, OH 44711
(708) 941-0205

Soils Control International, Inc.
P.O. Box 1214
Killeen, TX 76540
(817) 526-5550

Soil Stabilization Products, Inc.
P.O. Box 2779
Merced, CA 95344

ECO-Polymers
Evergreen Polymer Applications
Valencia Industrial Park
25020 Avenue Stanford, Suite 200
Santa Clarita, CA 91355
(805) 294-2260

Vendors For Lignosulfonate Type Dust Suppressants

Bell Marine Company, Inc.
775 Seaport Blvd.
Readwood City, CA 94063
(650) 369-9188
FAX (650) 369-6026

Lignosite Road Binder
Dustpro
2432 W. Peoria, Suite 1160
Phoenix, AZ 85029

Verdyol Dust Binder
Erosion Control Systems, Inc.
Suite 180
1800 McFarland Blvd. N.
Tuscalaloosa, AL 35406

Lignin LS-50
Prince Manufacturing Company
One Prince Plaza
P.O. Box 1009
Quincy, IL 62306
(217) 222-8854

Sailbond (Calcium Lignosulphonate)
Global Trading
14622 Ventura Blvd. #417
Sherman Oaks, CA 91403
(213) 300-4433
FAX (818) 990-0946

Raybinder (Sodium Lignosulfonate)
ITT Rayonier Inc.
1177 Summer Street
Stamford, CT 06904

APPENDIX C
PHOTOS OF SOIL SURVEY EQUIPMENT

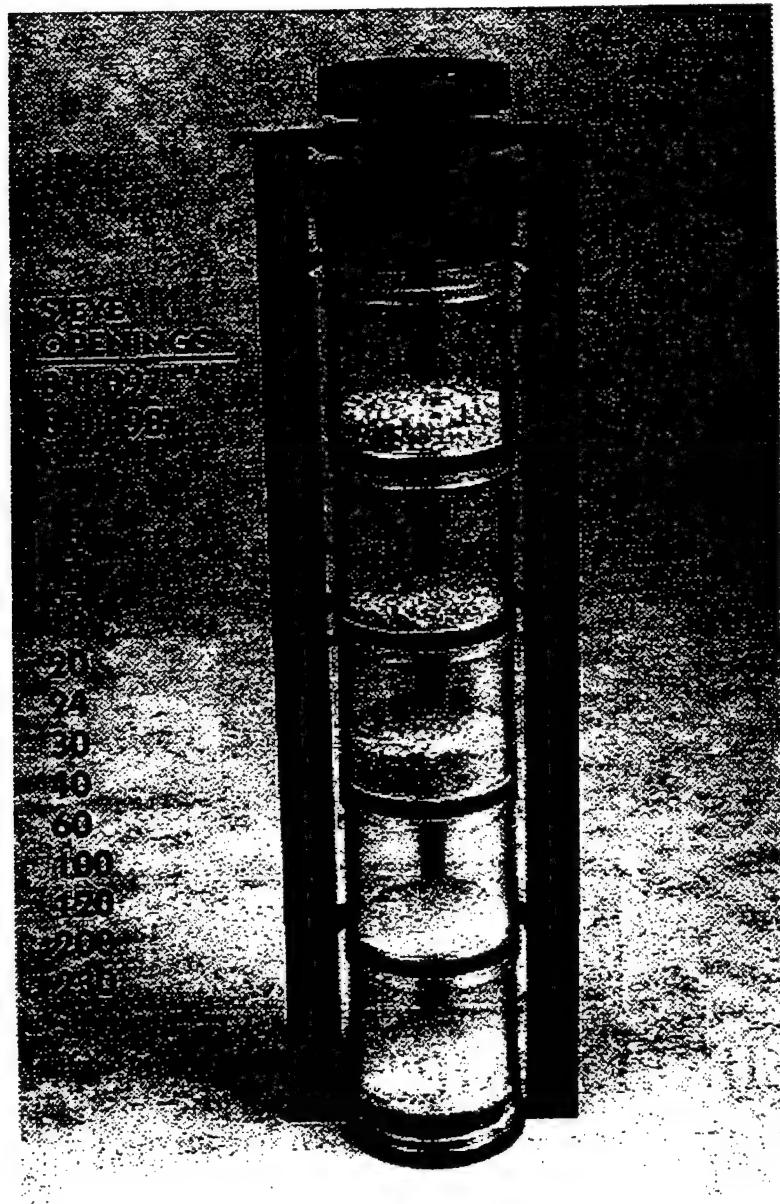


Photo C1: Soil Sieve

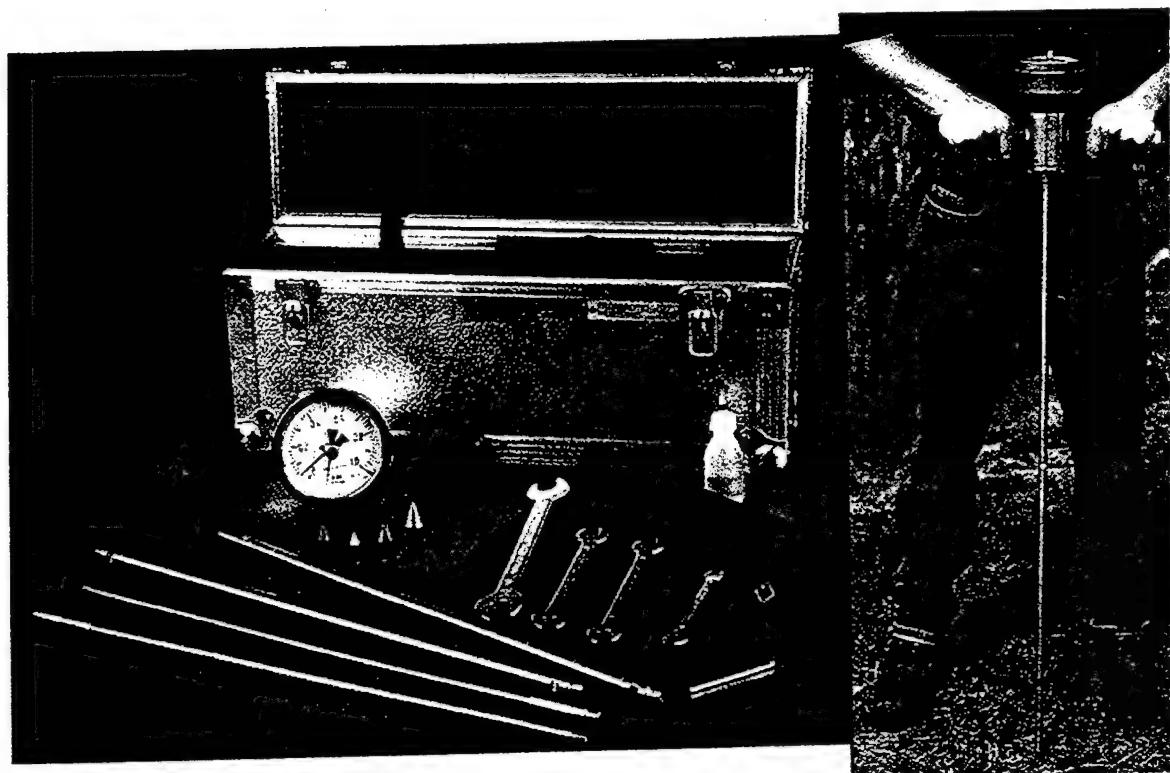


Photo C2: Penetrometer

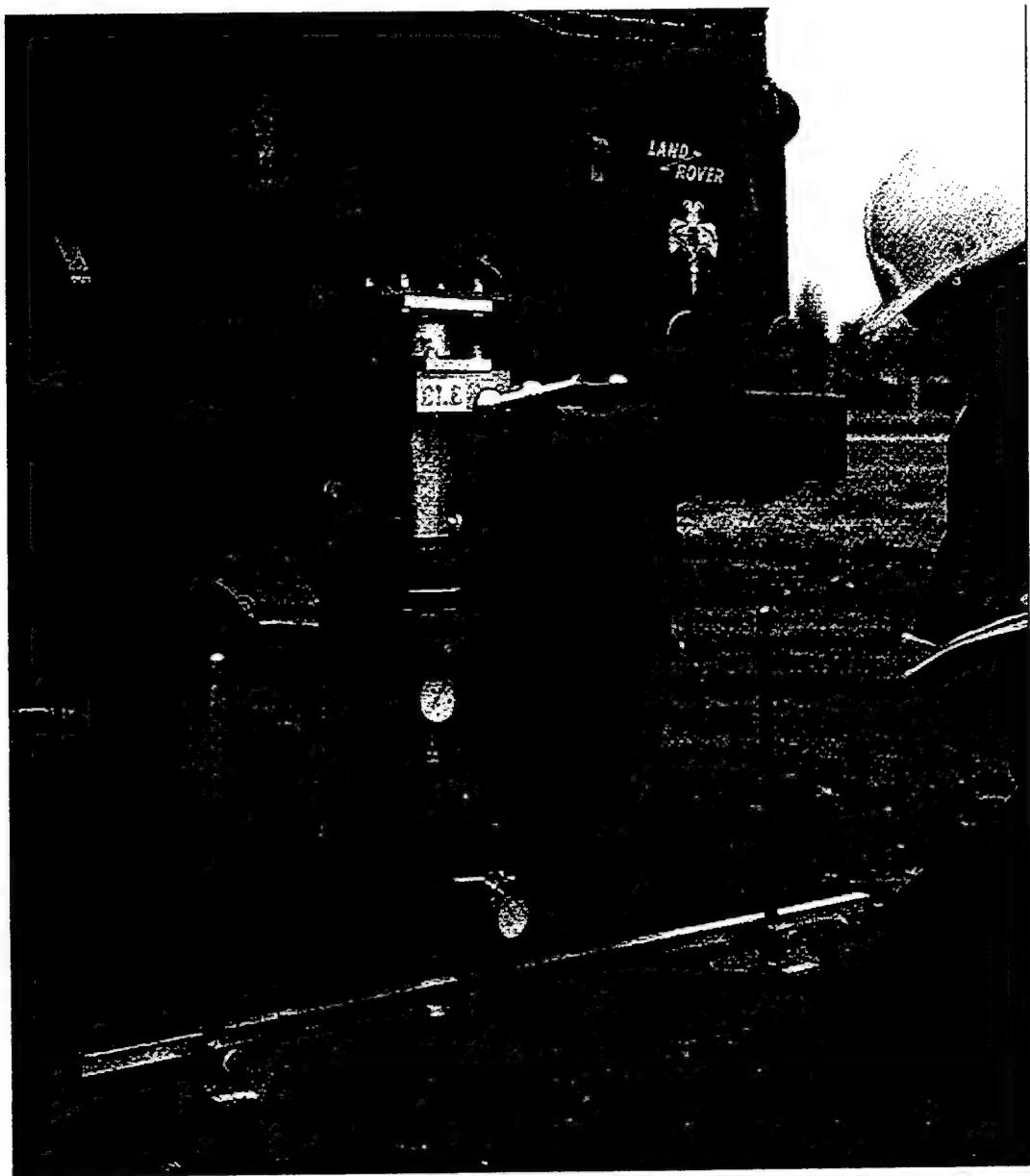


Photo C3: Field CBR Jack



Photo C4: pH Meter

APPENDIX D
DUST CONTROL SELECTION KEY FIELD GUIDE

Dust Control Selection Key

Field Guide

This key is designed to help military installations evaluate solutions for dust control problems. It recommends categories of chemical dust palliatives according to traffic volume, climatic factors, and soil types and textures. The recommended palliatives recorded the best results in both empirical studies and literature surveys, though products may be about 50% to 75% less effective in areas where tracked-vehicle traffic predominates.

Work through the questions in this key to find the most effective chemical dust palliative for your installation. For best results, you'll need the following data:

- predominant traffic type of the area supports
- estimated traffic volume during times of heaviest use
- characteristics of the trafficked surface, such as materials used to construct it, surface geometry, drainage patterns and maintenance schedules (all available from the Roads and Grounds division of the Directorate of Public Works)
- average annual precipitation
- predominant soil texture of the trafficked surface.

Dust Palliative Key

1. Has the area been identified as having a dust control problem?
 - a. Yes; go to 2
 - b. No; palliative may not be necessary
2. Does the area support military vehicle traffic?
 - a. Yes; go to 3
 - b. No; palliative may not be necessary
3. Does the area support aircraft traffic?
 - a. Yes; go to 4
 - b. No; go to 6
4. Is the type of aircraft fixed-wing?
 - a. Yes; go to 10
 - b. No; go to 5
5. Are the aircraft helicopters?
 - a. Yes; go to 43
 - b. No; go to 3
6. Does the area support land vehicles?
 - a. Yes; go to 7
 - b. No; go to 14

7. Are the vehicles tracked or wheeled?
 - a. Tracked; go to 9
 - b. Wheeled; go to 8
8. Estimated number of wheeled vehicle passes per day during periods of heaviest use:
 - a. More than 250; go to 11
 - b. Less than 250; go to 13
9. Estimated number of tracked vehicle passes per day during periods of heaviest use:
 - a. More than 100; go to 11
 - b. Less than 100; go to 13
10. Estimated number of aircraft landings per day during periods of heaviest use:
 - a. More than 50; go to 14
 - b. Less than 50; go to 13
11. Are permanent surface treatments, such as paving, economically feasible? Paving costs are about \$6 to \$10 per square yard, but can be significantly higher if predominantly tracked-vehicle traffic is expected because thicker pavement is required for satisfactory performance.
 - a. Yes; go to 12
 - b. No; go to 14
12. Apply permanent stabilization practices. Paving the surface will be more cost-effective than periodic unsurfaced road maintenance and regular application of dust suppressants.
13. Use of chemical dust suppressants may not be economically justified based on low traffic volumes. Good construction and maintenance practices are recommended instead. However, when safety or air quality concerns are a high priority, low traffic volumes should not preclude the use of chemical dust suppressants.
Go to 14
14. Has the surface been evaluated for geometry, materials, drainage, and maintenance practices?
 - a. Yes; go to 20
 - b. No; go to 15
15. Does the geometry of the surface appear to have a crown that facilitates drainage?
 - a. Yes; go to 16
 - b. No; go to 19
16. Do surface and subsurface materials appear to be stable and without significant potholing, washboarding, or other forms of erosion?
 - a. Yes; go to 17
 - b. No; go to 19

17. Does the surface have adequate drainage for local conditions?
 - a. Yes; go to 18
 - b. No; go to 19
18. Is surface maintenance performed on a regular basis?
 - a. Yes; go to 20
 - b. No; go to 19
19. Upgrades to drainage, surface and subsurface materials, grading, and/or maintenance practices may solve the dust control problem. Chemical dust suppressants should be considered if mechanical stabilization is not cost-effective and/or dust problems persist. Mechanical stabilization, which may include the addition, grading, mixing, and compaction of fresh aggregate materials, costs about \$2 to \$3 per square yard. Most installation Directorates of Public Works and state transportation departments can provide detailed information about mechanical stabilization practices and specifications.
Go to 20
20. Determine dominant climate influences, trafficked-surface soil textures, and suitable dust control product categories.
Go to 21
21. The climate of the installation is classified as:
 - a. Arid (less than 12" of precipitation per year); go to 22
 - b. Temperate (12"-36" of precipitation per year); go to 23
 - c. Humid (more than 36" of precipitation per year); go to 30
22. Soil texture of the trafficked surface is best classified as:
 - a. Sand/gravel; go to 24
 - b. Loam; go to 25
 - c. Clay; go to 26
 - d. Limestone; go to 27
23. The temperate climate is classified as:
 - a. Semi-arid (12"-24" of precipitation per year); go to 28
 - b. Sub-humid (24"-36" of precipitation per year); go to 29
24. Recommended product category for the trafficked surface:
Primary: Organic, Non-Bituminous; go to 43
see references 1, 20, 37
Secondary: Salts or Petrol; go to 43
see references 1, 4, 20, 31, 37
25. Recommended product category for the trafficked surface:
All product categories are suitable; go to 43
see references 10, 20, 31, 35

26. Recommended product category for the trafficked surface:
Primary: Organic, Non-Bituminous; go to 43
see references 20, 37
Secondary: Salts or Electro-Chemical Stabilizers; go to
43
see references 31, 35

27. Recommended product category for the trafficked surface:
Primary: Salts; go to 43
see references 31, 37
Secondary: Organic, Non-Bituminous; go to 43
see references 20, 37

28. Soil texture of the trafficked surface is best classified as:
a. Sand/gravel; go to 31
b. Loam; go to 32
c. Clay; go to 33
d. Limestone; go to 34

29. Soil texture of the trafficked surface is best classified as:
a. Sand/gravel; go to 35
b. Loam; go to 36
c. Clay; go to 37
d. Limestone; go to 38

30. Soil texture of the trafficked surface is best classified as:
a. Sand/gravel; go to 39
b. Loam; go to 40
c. Clay; go to 41
d. Limestone; go to 42

31. Recommended product category for the trafficked surface:
Primary: Petrol; go to 44
see references 10, 35
Secondary: Organic, Non-Bituminous; go to 44
see reference 20

32. Recommended product category for the trafficked surface:
Primary: Salts; go to 44
see references 1, 2, 10, 25, 27, 28, 32, 36
Secondary: Organic, Non-Bituminous; go to 44
see references 1, 2, 6, 10, 20, 25, 32, 36

33. Recommended product category for the trafficked surface:
Primary: Organic, Non-Bituminous; go to 44
see references 6, 20, 30
Secondary: Petrol; go to 44
see reference 20

34. Recommended product category for the trafficked surface:
Primary: Salts; go to 44
see references 18, 28
Secondary: Organic, Non-Bituminous; go to 44
see references 18, 30

35. Recommended product category for the trafficked surface:
Primary: Organic, Non-Bituminous; go to 44
see references 3, 11, 12, 13, 33
Secondary: Salts; go to 44
see references 18, 21
36. Recommended product category for the trafficked surface:
Primary: Organic, Non-Bituminous; go to 44
see references 3, 11, 12, 13, 16, 20, 23, 24, 33, 36
Secondary: Salts; go to 44
see references 3, 11, 12, 13, 16, 21, 24, 29, 36
37. Recommended product category for the trafficked surface:
Primary: Organic, Non-Bituminous; go to 44
see references 11, 12, 13, 20, 23, 24
Secondary: Electro-Chemical Stabilizers; go to 44
see reference 7
38. Recommended product category for the trafficked surface:
Primary: Salts; go to 44
see references 8, 15, 18, 21
Secondary: Organic, Non-Bituminous; go to 44
see references 15, 23
39. Recommended product category for the trafficked surface:
Primary: Petrol; go to 44
see references 20, 29
Secondary: Organic, Non-Bituminous; go to 44
see references 14, 18
40. Recommended product category for the trafficked surface:
Primary: Salts; go to 44
see references 16, 31
Secondary: Electro-Chemical Stabilizers; go to 44
see reference 29
41. Recommended product category for the trafficked surface:
Primary: Salts; go to 44
see references 4, 14, 20, 29
Secondary: Organic, Non-Bituminous; go to 44
see references 14, 20
42. Recommended product category for the trafficked surface:
Primary: Salts; go to 44
see references 4, 16, 17, 18
Secondary: Organic, Non-Bituminous; go to 44
see references 16, 17, 18
43. Recommended product category for the trafficked surface:
Primary: Polymers; go to 44
see references 17, 20
Secondary: Petrol; go to 44
see reference 20

44. The economic evaluation for prolonged and repeated use of this product at 60- to 90-day intervals is:
 - a. Economical; go to 45
 - b. Not economical; go to 46
45. A trial application of the product category has proven:
 - a. Effective; go to 47
 - b. Not effective; go to 46
46. Consider paving or use of an alternate dust palliative.
47. Implement large-scale use of product category and a monitoring program.

Once you determine the best chemical palliatives for conditions on your installation, consult the product manufacturers for application rates and concentrations. For more information on cost-effective dust control, check these publications:

- USACERL Technical Report 97/69. Gebhart and Hale. 1997.
- USAEC/USACERL Technical Report SFIM-AEC-ET-CR-96196. Gebhart and Hale. 1996.
- Dustproofing Unsurfaced Areas: Facilities Technology Application Test Demonstrations, FY 84. CEWES Technical Report GL-85-11. Styron III, et. al. 1985.
- Dustproofing Unsurfaced Areas: Facilities Technology Application Test (FTAT) Demonstration, FY 85. CEWES Technical Report GL-86-20. Robert A. Haas. 1986.
- Dustproofing Unsurfaced Areas: Facilities Technology Application Test (FTAT) Demonstration, FY 86. CEWES Miscellaneous Paper GL-87-19. Jeffrey P. Armstrong. 1987.
- Consumers Guide to Dust Control Technologies. J.P. Zaniewski and A.K. Bennett. 1989.

For more information contact:
[U.S. Army Environmental Hotline](#)
(800) USA-3845, DSN 584-1699



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APPENDIX E
PHOTOS OF EQUIPMENT

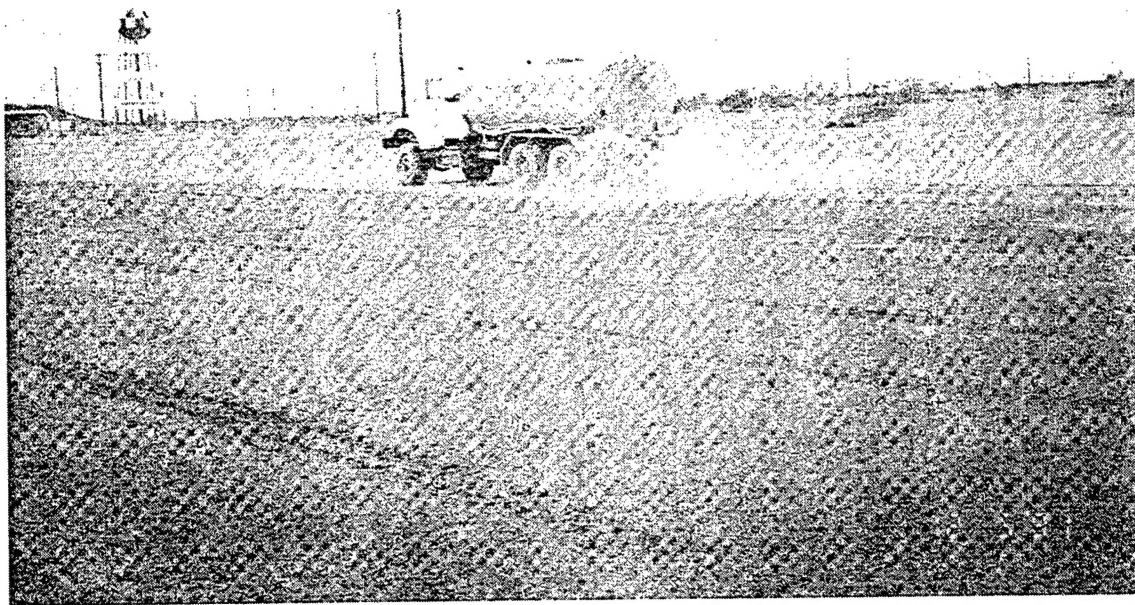


Photo E1: Water Truck

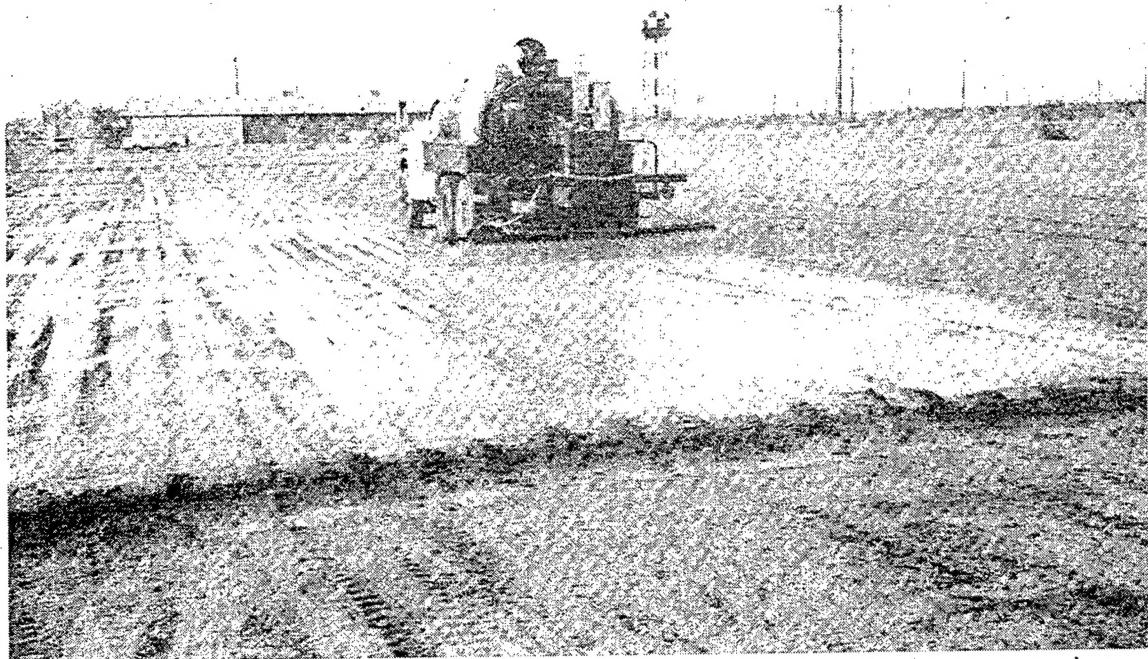


Photo E2: Asphalt Distributor



Photo E3: Motor Grader

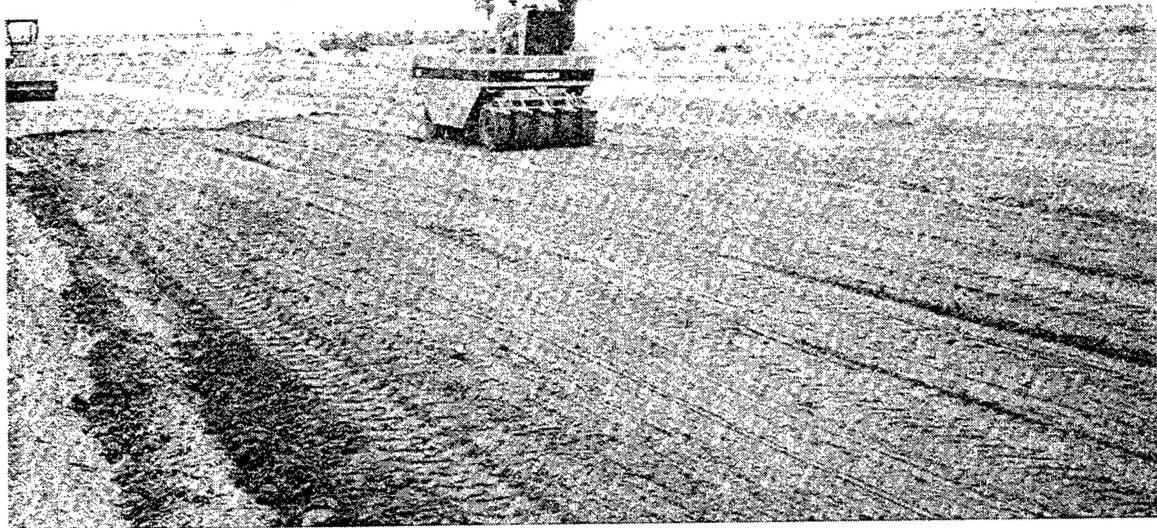


Photo E4: Drum Compactor